SUBSTITUTE SPECIFICATION

Our Reference: VMP-491-A PATENT

DEVICE FOR DETECTING PARTICLES ON A WINDSHIELD

BACKGROUND

[0001] The present invention relates to a device for detecting particles on a windshield of a motor vehicle with a radiation source which emits optical rays onto the windshield with a photodetector, which receives some portion of the rays projected onto the windshield and with a control unit which manages the radiation source and analyzes the rays received by the photodetector.

[0002] In the sense of this invention, particles are understood to be both drops of liquid (e.g., vapor, rain, etc.) as well as small solid particles (e.g., dust, grains of sand, ice crystals, snow, hail, etc.). Particles are accordingly everything that can hamper vision through the windshield of a motor vehicle.

[0003] Devices of this kind are known in different embodiments from the prior art. Such devices are normally attached flush to the windshield in the vehicle interior. The area between the radiation source and the photodetector in the device and the windshield is filled with a contact material which possesses a similar optical density to the glass in the windshield. The radiation source emits optical rays onto the windshield. Next to the radiation source is the photodetector, which either receives those rays which were scattered by the particles on the windshield and/or the rays which were reflected by the windshield and not scattered by the particles. The control unit analyzes the rays received by the photodetector. It determines, for example, what type of particles they are and how many of these particles are located on the windshield. The control unit can also take suitable measures to remove these particles from the windshield. The

measures include, for example, activating a windshield wiper or a windshield washer system.

[0004] In the case of the known devices, it is disadvantageous that the devices are attached flush to the windshield and the optical rays run inside the windshield. As a consequence, only particles on the outside of the windshield can be detected. Particles on the inside of the windshield cannot normally penetrate between the device and the windshield and consequently are not detected by the known devices. In addition, the contact material which is introduced between the device and the windshield does not possess exactly the same optical density as the glass in the windshield. Consequently, the optical rays are always refracted a little in the transition from the contact material into the windshield and in the reverse direction, whereby the results of the analysis by the device can be falsified. Finally, it proves to be disadvantageous in the known devices that they are positioned outside the vehicle driver's field of view. They are normally located at the upper edge of the windshield which is just barely touched by a windshield wiper. The results of the analysis by the device therefore apply to an area outside the driver's field of view. With particles distributed irregularly on the windshield it can happen that there are no particles deposited in the area of the windshield where the device is located, and consequently the device cannot detect any particles and appropriate measures to remove particles from the windshield are not taken, even although a large number of particles are deposited in the driver's field of view and obstruct his sight. The known device cannot simply be positioned in the driver's field of view because it would otherwise detract from the driver's vision.

[0005] From the aforementioned disadvantages of the prior art comes the task of the invention to configure and develop a device of this type so that particles in the field of view of a vehicle driver can be detected reliably without the device being located in the driver's field of view.

SUMMARY

[0006] In order to fulfil this task the invention proposes, starting with the device of the type named above, the radiation source is located outside the field of view of a driver of the vehicle and is aligned in such a way that the optical rays from the radiation source strike the windshield in the area of the driver's field of view, and that the photodetector is directed at the area of the windshield where the rays from the radiation source strike it.

[0007] The field of view is the area of the windshield at which the driver of the vehicle looks when he is looking at the roadway ahead of the vehicle. The field of view is approximately equivalent to the area of the windshield which is swept by windshield wipers to remove the particles located on the outside of the windshield. The device according to the invention for detecting particles encompasses a considerably larger area of the windshield than a sensor flush-mounted to the windshield.

[0008] The device according to the invention can be positioned outside the field of view of the driver. The driver's vision is not impaired by a device located within his field of view. Nevertheless, by means of the device according to the invention, the driver's field of vision or another adequately large representative area can be monitored. In this way, particles in the driver's field of vision can be reliably detected. The optical rays preferably strike the windshield at a similar angle as the driver's line of vision strikes the windshield. In this way precisely those particles which result in the driver's vision through the windshield being impaired can be detected.

[0009] The separation of the arrangement of the device in the vehicle and the area to be monitored is made possible by the fact that the device according to the invention departs from the previously normal method of construction and is no longer flush-mounted on the windshield, as was previously customary. Instead an air gap is created between the radiation source and the windshield and between the photodetector and the windshield.

[0010] The device according to the invention has the further advantage that particles can settle in the vehicle interior as well, in the area of the windshield in which the optical rays from the radiation source strike and at which the photodetector is directed. Just like the particles on the outside of the windshield, these particles on the inside of the windshield can also be detected by the device according to the invention.

[0011] In accordance with an advantageous embodiment of the present invention, the radiation source is formed as a light-emitting diode (LED).

[0012] The photodetector preferably possesses several receiving units. The receiving units are advantageously formed as optoelectronic arrays such as charge-coupled device (CCD) image converters.

[0013] In accordance with an advantageous development of the invention, means to focus the rays are positioned in front of the receiving units in the direction of propagation of the rays reflected by the particles. The means to focus the rays are preferably formed as lenses.

[0014] The radiation source preferably emits optical rays with a wave length of about 350 nm to 800 nm. These optical rays lie within the range of light visible to the human eye. By using optical rays in this frequency range, particles on the vehicle windshield can be detected with particular reliability. However, radiation sources can also be used which emit rays with a wave length in the infrared range.

[0015] In accordance with a particularly preferred embodiment of the present invention, the control unit manages the radiation source in such a way that the type of particle can be determined from the rays received by the receiver. In this way different measures can be taken as required to remove the particles in question from the windshield. In the case of dirt or dust on the outside of the windshield, the windshield washer system should be activated first and then a windshield wiper, so that the particles can be removed from the windshield without scratching it. In the case of rain, snow or hail it is sufficient to activate a windshield wiper. If extremely small drops

of moisture form on the inside of the windshield, known as fogging, the ventilation system can be activated as well as the vehicle interior heating system as needed.

[0016] In order to make it possible to distinguish the type of particle on the windshield with the device in accordance with the invention and in order to be able to determine whether the particles are located on the outside or on the inside of the windshield, the radiation source emits optical rays with different frequencies. The intensity of the rays can also be varied. Additionally the radiation source can also emit ray pulses of different duration. Depending on the type of particle, all these different optical rays result in characteristic reflections through the corresponding particles. By means of suitable analysis by the control unit of the rays reflected from the particles and received by the photodetector, the type of particle can be determined with great accuracy.

[0017] Alternatively, or additionally, the invention proposes in accordance with an advantageous development that the control unit analyzes the rays received by the photodetector by means of suitable algorithms, so that the type of particle can be determined.

[0018] In accordance with a preferred embodiment of the invention the device is an integral part of an interior light module of a motor vehicle. As a result, the device in accordance with the invention can be located unobtrusively for the driver out of his field of vision. However, the device is positioned in such a way that the optical rays from the radiation source can reach the driver's field of vision on the windshield unobstructed. Additionally, the optical rays in the case of a device positioned in this way strike the windshield at a similar angle to the driver's line of sight.

[0019] Alternatively, it is proposed that the device in accordance with the invention is an integral part of a rearview mirror module of a motor vehicle.

[0020] Particular advantages result if the device in accordance with the invention is connected over a bidirectional data bus to a superordinate

control unit in the vehicle. In this way the results of the analysis from the device can be supplied to the control unit and processed there. So the control unit can, for example, in conditions of heavy rain or thick blowing snow cause the potential top speed of the vehicle to be restricted or activate the vehicle lighting system.

BRIEF DESCRIPTION OF THE DRAWING

[0021] A preferred embodiment of the present invention is explained in greater detail below using the drawings in which:

[0022] Figure 1 shows a schematic view of a device under the invention; and

[0023] Figure 2 shows a side view of a device under the invention in accordance with an initial embodiment.

[0024]DETAILED DESCRIPTION

[0025] In Figure 1 the device of the invention is identified in its entirety with the reference numeral 1. The device 1 is used to detect particles 2 on a windshield 3 of a motor vehicle 10 (see Fig. 2). The device 1 possesses a radiation source 4 which emits optical rays 5 onto the windshield 3. The radiation source 4 is formed as a light-emitting diode (LED). In addition, the device 1 possesses a photodetector which receives the optical rays 7 reflected from the particles 2 on the windshield 3. The photodetector is designed as a charge-coupled device (CCD) image converter. Finally, the device 1 possesses a control unit 8 which manages the radiation source 4 by means of control signals 9 and which analyzes the optical rays 7 received by the photodetector 6. Means 12 for focusing the optical rays 5, 7 are located in the direction of propagation of the beams 5 after the radiation source 4 and in the direction of propagation of the beams 7 in front of the photodetector 6. The means 12 for focusing the beams 5, 7 are formed as lenses. The device 1 according to the invention is connected over a bidirectional data bus 9 to a superordinate control unit (not shown) in the vehicle 10.

[0026] Figure 2 shows a section of the interior of a motor vehicle 10. A unit 11 made up of an interior light module 11a and rearview mirror module 11b is located in the roof of the vehicle 10. The device 1 of the invention is an integral part of this unit 11. The device 1 is positioned outside the field of view of the driver (not shown) of the vehicle 10 and does not obstruct the driver's view of the road in front of the vehicle 10. The optical rays 5 from the radiation source 4 can strike the driver's field of view on the windshield 3 of the vehicle 10 unobstructed, and the optical rays 7 reflected from the particles 2 on the windshield 3 can reach the photodetector 6 unobstructed.